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ABSTRACT

Feedback from assessments should be the foundation for improvements students make in their lab work. Therefore, in this study, a standard rubric that reflected the scientific method was employed as an intervention to assess student lab write-ups. Students preformed three labs all based on consumer research. The first lab was completed without the use of a rubric. The second and third labs were done using the rubric as a guide for the lab write-up. Students also participated in peer editing sessions and self-evaluations of their labs. The use of a rubric and templates helped students achieve high-level performance in the lab work they completed in the classroom. The average score on lab write-ups increased by 17%. The rubric also provided an efficient, effective, and consistent means to assess students' lab write-ups. Evaluation time was reduced by five hours and consistency was documented with inter-rater agreement for the post intervention lab. Overall, the implementation of a standard rubric to assess student lab write-ups increased student success, provided a means to achieve high quality work, and sufficiently reduced evaluation time by the instructor. (Author/SOE)

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Student Improvement in Middle School Science

Yvonne K. Mullen
May 2003

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STUDENT IMPROVEMENT IN MIDDLE SCHOOL SCIENCE

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A Seminar Paper Submitted in Partial
Fulfillment of the Requirements
For the Degree of

Master of Science in Education

Curriculum and Instruction

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May 2003

Approval Date

First Reader: _____
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Second Reader: _____
Ms. Kathryn DeKarske

Abstract

I have always been concerned with assessing lab write-ups in a timely manner for students in my seventh-grade life science classroom. Feedback from assessments should be the foundation for improvements students make their lab work.

A standard rubric to assess student lab write-ups was employed as an intervention. The rubric reflected the scientific method. Students preformed three labs all based on consumer research. The first lab was completed without the use of a rubric. The second and third labs were done using the rubric as a guide for the lab write-up. Students also participated in peer editing sessions and self-evaluations of their labs.

The use of a rubric and templates helped my students to achieve high-level performance in the lab work they complete in my classroom. The average score on lab write-ups increased by seventeen percent. The rubric also gave me an efficient, effective and consistent means to assess my students' lab write-ups. Evaluation time was reduced by five hours and consistency was documented with inter-rater agreement for the post intervention lab. Overall, the implementation of a standard rubric to assess student lab write-ups increased student success, provided a means to achieve high quality work and sufficiently reduced evaluation time by the instructor.

Timeline for Action Research

July

- Attended Action Research Class – Part 1
- Explored possible problem areas in my classroom
- Narrowed problem down
- Completed ERIC search

August

- Completed another ERIC search
- Located needed source of information for Literature Review
- Wrote Statement of Problem
- Wrote Research and Related Questions
- Began writing Situating the Problem

September

- Finished Situating the Problem
- Read and highlighted literature
- Students completed Paper Towel Lab according to scientific method notes
- Graded Paper Towel Labs (approx. 2.5 hours per class)

October

- Wrote Literature Review
- Designed and implemented rubric and templates with Barney Juice Lab
- Students completed second controlled consumer lab (Stain Remover Lab)
- Wrote Intervention section of Action Research Paper

November

- Conducted Inter-rater Agreement Task
- Interviewed students with Post Intervention Survey
- Wrote Results and Findings section of Action Research Paper
- Changed paper to past tense
- Had two individuals read and edit Action Research Paper
- Turned draft of Action Research Paper in to Dr. Hankes

January

- Met with Dr. Hankes in regards to revision and editing changes
- Wrote Abstract for Action Research Paper

February

- Met with Dr. Lemberger in regards to editing and revision changes
- Gave paper to second reader (Ms. Kathryn DeKarske)

Statement of Problem

In the past, I have required students in my seventh grade life science class to write extensive lab reports that described experimental findings and reported conclusions. Assessing those reports took countless hours. Consequently, I was unable to provide beneficial feedback in a timely manner. I conducted this study to determine whether using rubrics to assess lab reports would decrease assessment time and improve student work.

Situating the Problem

I am in my seventh year of teaching, and for the past four years I have been teaching seventh-grade life science. Prior to teaching science, I taught two years of middle school English and one year of eighth-grade earth science.

I have always held very high expectations for my students. Lab reports in my class were expected to be accurate, concise and well written. However, I realized that I lacked an efficient and direct way to evaluate work. In the past, I have had students complete lab write-ups with very little written direction. I knew what I wanted but was not relaying that information in an effective manner to my students. The quality of labs I received varied greatly. I expected that my students should know what quality work in science should look like. However, I failed to realize that most of my students came to me with very little or no background in doing labs and writing scientific lab reports.

When grading the labs, I often found myself changing my grading criteria as I corrected the labs. Sometimes I would not grade an error until I saw the repetition of the error on other papers. Then I would go back and reassess all the labs I had previously graded. This added greatly to the tremendous amount time I was devoting to correcting

the students written work. To alleviate the problem, I tried to evaluate using checklists. Although this helped some students remember what to do, it never improved the quality of their work. They continued to make the same mistakes over and over.

Time was another problem I encountered while grading lab work. The longer I spent grading the labs, the less time I really spent reading them. After countless nights of reading students' lab write-ups, I would just skim the last ones to get them done and returned to the students. As a result, the final labs often lacked beneficial feedback and often received a higher grade than the labs I corrected in the beginning. On average 10-15 hours were required per set of lab write-ups.

Few students took the time to look over their labs and read my comments. It appeared that the students were only interested in the final grade on the report. They did not pay attention to what the lab was about or consider areas of weakness that they should improve upon. As a result, the next set of lab reports would come in with the same errors and the process of grading them would start all over again.

Based on educational research, I decided to implement a scoring rubric to reduce my time spent grading lab reports and increase the quality of the students' work.

Literature Review

Rubrics have become popular among educators moving towards authentic and performance-based assessment. Science instruction trends have shifted towards application of information and skills rather than factual knowledge. This has precipitated the need to evaluate and assess student learning based on performance, in addition to the traditional paper-and-pencil test. Performance assessment requires authentic means to

measure student achievement. Consequently, the use of rubrics is beginning to weave its way into assessment within the science classroom.

What Is a Rubric?

"A rubric is defined as a set of scoring guidelines for evaluating student work" (Montgomery, 2000). There are two main types of rubrics that are often utilized. They are analytic rubrics and holistic rubrics. Analytic rubrics are used to award points for very specific responses on different portions of an assessment. This type of rubric is more process oriented. It is very concrete as to how points will or will not be awarded. This allows little room for subjectivity. Holistic rubrics are used when the teacher want to assess the overall quality of a student's response. Holistic rubrics therefore are more product oriented. They are used to assess the end product more so than the process to achieve the final product (Finson & Ormsbee, 1998).

Why Use Rubrics?

Rubrics appeal to teachers, parents and students for many reasons. First rubrics can be influential tools for teaching and assessment.

> "Rubrics can improve student performance, as well as monitor it, by making teachers' expectations clear and by showing student how to meet these expectations. The result is often marked improvement in the quality of student work and in the learning. Thus, the most common argument for using rubrics is they help define 'quality'" (Andrade, 1997).

Traditionally, teachers kept the criteria and standards to themselves. They expected students to know what quality work was without clearly outlying expectations. With traditional assessment, the success of the process or product was often left up to chance. The introduction of rubrics changed both instruction and assessment. They clarify expectations so that students who understand what is expected of them are more likely to

achieve top-level performance. Since students know the criteria that will be used to evaluate them, they have little excuse for not working towards top-level performance (Liu, 1995).

Secondly, rubrics motivate student to produce high-quality work. When students know the criteria for each gradation in the rubric, they aim to achieve that level. In research conducted by a high school teacher in Hillsboro, Oregon, the teacher discovered, after interviewing her students about using a rubric that they were motivated to work towards top performance levels. One of her students commented:

> "'I liked having the guide in front of me while preparing my presentation. I automatically tried for a straight A and knew what was expected. I really liked the idea of having the concrete expectations for an assignment and to know exactly what I needed to do to get the grade I wanted'" (Young, 1997).

Young (1997) realized rubrics gave her what many educators want in their classrooms: top-level performance.

Thirdly, rubrics are utilized because they guide students to be better evaluators of their work and the work of their peers.

> "When rubrics are used to guide self- and peer-assessment, students become increasingly able to spot and solve problem in their own and one another's work. Repeated practice with peer-assessment, and especially self-assessment, increases students' sense of responsibility for their own work and cuts down on the number of 'Am I done yet?' questions" (Andrade, 1997).

The two key components that help student become better at evaluating their work are providing opportunities for self-assessments and distributing the rubric at the beginning of the unit or project. Self-assessments are valuable tools that help the student grow and provide feedback to the teacher regarding the student's comprehension.

> "Teachers need to enable students to take ownership for their work through reflection on why their work was either quality work or in need of improvement. Teachers can give students a chance to assess their own work by asking them to complete the same assessment rubrics that teachers are using...The teachers' awareness of the student's ability to self-assess accurately may give valuable clues as to how deeply the student understands the tasks" (Montgomery, 2000).

By distributing the rubric at the beginning of the unit or project the teacher is relaying to the student the information that is important. As students work through the unit or project they can refer back to the rubric to gain key insights regarding the expectations of the teacher. In addition, when the same rubric is used to develop skill mastery, students can reflect on previous work to make plans for improvement when completing tasks that focus on the same skill.

Fourthly, rubrics provide an explanation and justification of the grade. Students receiving feedback from peers, teachers and themselves find it difficult to dispute a grade. The grade is dictated by the rubric, not the teacher's subjective opinion.

> "Grades were validated by the scoring guide. Explanations and justification were definitive because of the scoring guide, and therefore the grades were satisfactory to them (the students). Grades based on the specific distinction of a scoring guide are equally clear to parents and administrators" (Young, 2000).

The rubric also helps parents who would like to help their children with homework. Parents can refer to the rubric or scoring guide to help their child's progress through the unit or project and make every attempt to achieve top-level performance. With the use of rubrics, parents know exactly what their child needs to be successful.

Finally, rubrics can reduce the amount of time teachers spend evaluating student work. By the time student work is turned into the teacher, it has been evaluated by at

least two other people. With this being done, the amount of errors should be minimal and the development of the piece should be substantial.

> "Teachers tend to find that by the time a piece has been self- and peer-assessed according to the rubric, they have little left to say about it. When they do have something to say, they can simply circle an item in the rubric, rather than struggling to explain the flaw or strength they have noticed and figuring out what to suggest in term of improvements" (Andrade, 1997).

Teachers can then evaluate the work quicker and more efficiently. This allows students feedback for improvement in future units or projects. Also less time spent evaluating student work means the teacher has more time to research and implement other effective strategies for student education.

Overall the use of rubrics benefits teachers, parents and especially students. With students motivated to achieve high-level performances, they gain valuable insight into improving their education, which is every parent and teacher's aspiration.

Process of Creating and Implementing a Rubric

There are numerous publications and websites containing ready-made rubrics. Most educators will need to create a few rubrics that will fit their own curriculum and teaching style. Although constructing your own rubrics can be tedious and time-consuming, a number of tools are available to help make the job easier and more reliable. Andrade (1997, 2000) offers a simple, yet successful list of steps to creating a rubric:

> **1. Look at models:** Show students examples of good and not-so-good work. Identify the characteristics that make the good ones good and the bad ones bad.
> 2. **List criteria:** Use the discussion of models to begin a list of what counts in quality work.
> 3. **Articulate gradations of quality:** Describe the best and worst levels of quality, then fill in the middle levels based on your knowledge of common problems and the discussion of not-so-good work.
> 4. **Practice on models:** Have students use the rubrics to evaluate the

models you gave them in Step 1.
5. **Use self- and peer-assessment:** Give students their assignment. As they work, stop them occasionally for self- and peer-assessment.
6. **Revise:** Always give students time to revise their work based on the feedback they get in Step 5.
7. **Use teacher assessment:** Use the same rubric students used to assess their work yourself (Andrade, 1997,2000).

Designing the most effective rubric for the unit or project can be the key to success for the entire learning experience.

There are some common challenges that face educators who are constructing their own rubrics. The most common and perhaps the most difficult challenge is the use of common language. Educators need to avoid phrases that are difficult to define, such as "creative." Instead the creator of the rubric should define aspects of "creative." Another challenge in designing a rubric is avoiding negative language, such as "dull." Being as specific as possible will help the student make the needed improvement, instead of concentrating on the negative aspects of the student's work. Another test of designing a rubric is to avoid overuse of detail. By using too much detail the rubric will become lengthy, and busy teachers do not have the time to use a lengthy, drawn-out rubric.

> "For openers, a rubric should contain three to five evaluative criteria. Its is tempting to lay out all of the possible criteria that could be used to judge students' responses; but rubric developers should remember that their efforts should guide teachers, not overwhelm them. In rubrics, less is more" (Popham, 1997).

The final challenge is articulating gradations of quality. It is easiest to start with the highest and lowest gradations and then work on what is missing from the gradation for the middle levels (Andrade, 1997). It is important to remember that rubrics often require revision after they have been implemented in order to best determine student performance.

Once the rubric is completed the teacher needs to involve the students in the use of the rubric. Andrade suggests that copies of the rubric be given to students and that students be directed to assess their own progress on a task or project. This assessment should not count towards a grade (Andrade, 1997). The reason for this is to help students work towards a better final product. Time is another important factor in the implementation of a rubric. Students need time to revise their work after they have self- or peer-assessed. Finally, when assessing student work it is imperative that the teacher uses the same rubric as the students. This allows students to gage their strengths and weaknesses.

Using Rubrics With Special Needs Students

"Because of the emphasis on experiments and active learning, science classes seem to be one of the most accessible – and accessed – subjects for inclusive programming" (Finson & Ormsbee, 1998). With this growing trend, additional resources are needed to assess students with learning disabilities in the science classroom. However, there has been little research regarding the modification of science activities and assessment for students with special needs. Analytic rubrics can make a positive impact on the evaluation of students with special needs.

Using an analytic rubric with special needs students allows students to achieve points for each step in the process even if the overall product is lacking the desired quality. The structure of an analytic rubric helps most EEN students be successful, because the gradations often include specifics instead of generalities.

The use of rubrics with special needs students regarding skill development lends itself to concentrating on the progress that is made over time. Alternative grading can be an option with some students. The rubric can be used to grade on improvement.

> "Rubrics make assessing student work quick and efficient, and they help teachers justify to parent and others the grades that they assign to students. At there very best, rubrics are also teaching tools that support student learning and the development of sophisticated thinking skills. When used correctly, they serve the purposes of learning as well as of evaluation and accountability" (Andrade, 2000).

Rubrics can be the tool that teachers, parents and students have been searching for regarding direction with teacher instruction of curriculum and improvements and quality in student work.

Methodology

Research and Related Questions

The general question of this research was:

Can rubrics provide an accurate and timely means to provide feedback to my students?

Sub-questions were:

- Can a universal lab rubric accurately assess lab reports with inter-rater agreement?
- Can a rubric reduce assessment time?
- Can a rubric help students to focus on requirements prior to the assessment?
- Can a rubric help improve the work of exceptional educational needs students?

Research Design

Action research is a teacher owned research process that identifies practical problems within a classroom. It looks at everyday issues experienced by teachers. Through action research teachers identify a problem area, formulate questions to research, implement researched techniques or methods to obtain the improvements needed. The improvements are then documented through reflective journals, surveys, or a host of other data collection techniques.

As a teacher I chose the action research design method because I wanted to look at a practical and continuous problem within my classroom. I was not looking at a "theoretical problem." Also I was looking for an opportunity to reflect and improve upon my own teaching practice.

Intervention

Developing a rubric.

The development of the rubric that became the foundation for my classroom began with the scientific method. Lab write-ups in my class were based on the scientific method; therefore, the groundwork of the rubric followed the same process.

The first step in developing the rubric, involved reflection on labs completed by previous students. I noted positive as well as negative qualities on the labs. This helped me understand what I truly was looking for in my students' work. Next I solicited ideas from co-workers in various teaching assignments. I wanted to evaluate my students' science knowledge as well as their ability to

communicate their findings to their peers. I found the English department to be helpful in regards to the written format of my students' lab write-ups.

The rubric required a format that was simple enough for my students to follow, yet provided all the needed criteria. I chose to use an analytical rubric because I wanted to concentrate on the parts of the process instead of the final product. I felt this would allow my students to see their strengths and weaknesses and make the needed changes over their academic year in science.

Upon completion of the rough draft of the rubric, colleagues and my students provided feedback. Students identified confusing aspects. They suggested adding division lines for each concluding paragraph. A second revision occurred after students completed their first lab.

Inter-rating agreement.

To check the consistency of the rubric two other science teachers in my building evaluated three students' post intervention labs using the rubric. The teachers had very little background on the objective of the lab, and were given no directions regarding the rubric and how it was to be interpreted. None of the scores were shared with the teachers until all labs had been evaluated.

Both of the evaluators found the rubric to be easy to follow and felt they would get faster at evaluating labs with practice. After reviewing the PHEOC handout and Conclusion Template the rubric became even clearer. Overall, the scores proved that the rubric was a consistent evaluation tool that could be implemented by the teachers in my department.

Comparison of Inter-rater Scores

Evaluator	Score/40		
	Student A	Student B	Student C
7th grade teacher (myself)	30	40	37
7th grade teacher	32	40	36
8th grade teacher	29	40	36

Gathering base line data.

Baseline data was gathered by having students conduct a controlled consumer lab based on the question, "Which paper towel is the best buy?" Prior to beginning the lab, students were instructed in the steps of the scientific method.

Students gathered information about three different brands of paper towels and discussed possible tests we could run. Each student then formulated a hypothesis based on the background information they had acquired. With their lab partners, students designed a lab based on the scientific method to test their hypothesis. Each student was responsible for her own lab write-up, including a well thought out conclusion. Lab write-ups were unedited and disorganized.

Implementing the rubric.

Intervention began by reteaching the scientific method using a graphic organizer entitled PHEOC Handout (see Appendix A). The graphic organizer accomplished three objectives. The graphic organizer helped my students visually understand the scientific method as a process instead of an activity to be completed. Secondly, the graphic organizer provided assistance in writing up lab reports. Students were directed to refer to the organizer when writing their reports if they were confused about specifics of a step in the process. Finally, the graphic organizer served as a permanent reference tool for my

students. After reteaching the scientific method, students were introduced to the rubric (see Appendix B) and explained how it would be used to evaluate their labs throughout the year.

Use of the rubric was modeled using an overhead projector. Three different versions of the same lab were presented. One was a high quality, well-written lab report that would receive the high end marks on the rubric. The next lab was of average quality that would receive the middle level marks on the rubric. Finally, I showed my students what a low quality lab write-up looked like. Students then practiced evaluating labs using the rubric, labs that were completed by students in previous years.

Guided use of rubric.

The rubric was first tested and implemented with a new lab, The Barney Juice Lab (see Appendix C). Students worked with lab partners to complete each section of the lab, excluding the problem. At the end of each hour, we spent 15 minutes discussing the progress they had made using the PHEOC Handout and rubric.

Upon completion of the lab, students were provided with templates (see Appendix D) to help with the lab report. Rough copies were peer-edited. Students used the signal words handout (Appendix E) to help make their writing flow. Over the weekend, students generated a final copy of the lab write-up and were required to self-assess it prior to turning it in. The result, lab write-ups were more polished and better written, but one question remained. Could students use the rubric independently?

Independent use of rubric.

The final step in my intervention was to have the students use the tools and knowledge they gained to fully implement the rubric independently. Because students

completed a lab on consumer testing for baseline data the same theme was used to gather final data. Students designed a lab based on stain removers and their effectiveness on various types of cloth. I made sure the students understood that this was a controlled lab; therefore they could only test one variable (cloth, stain or remover).

Students were not given a partial materials list or the beginning steps of the procedure as with the Barney Juice Lab (working through interventions). They were on their own to develop the entire lab just as they were with the Paper Towel Lab (baseline data). My intention was for students to use the knowledge and skills they gained in the previous labs write-ups to produce labs of higher quality. The higher quality lab write-ups would in turn reduce my grading time because there would be fewer errors to correct.

Participants

The school where I teach is one of three middle schools, in one of the five largest cities in the state of Wisconsin, serving approximately 15,000 students. The middle school has approximately 760 students and 75 staff members. There are three seventh-grade teams and three eighth-grade teams in the building. Each team consists of five team teachers, a counselor and learning specialist.

The study population was comparable to students I have taught in the past. Predominately, the students attending this school come from Caucasian families with average socioeconomic status. The study consisted 131 students. Twenty-four were identified as exceptional educational needs (EEN). The average class size was twenty-six students. There were five sections of science. During three of the sections, I was assisted by an educational assistant due to the large number of special needs students in the class.

Data Collection

Data to support the action research was collected through quantitative documentation of student scores on three similar lab reports, inter-rater agreement of the post intervention lab report and a post intervention survey regarding the use of a rubric and templates was given to the students involved in the research. A reflective journal was also used to document day-to-day activities and changes. The methods for data collection gave a clear picture of the action research from the teacher and student perspectives.

Data Analysis

Quantitative documentation of students' scores was gathered by comparing students' baseline scores of the lab report to post intervention scores of the final lab report. The teacher acquired students' baseline scores through evaluating lab reports without the use of a rubric. Following the implementation of the rubric the students and teacher used a rubric to evaluated the post intervention labs. The average score increased from a 65% to an 82%. The EEN students increased their average score from a 68% to a 77%. The labs were of similar content and format. All student labs were included in the averages.

Quantitative documentation was also used to determine the decrease in evaluation time and inter-rater agreement. Evaluation time was decreased from 11.5 hours for the baseline data labs to 6.5 hours for the post intervention lab with the use of a rubric. The consistency of the intervention (rubric) was supported with two unbiased raters. The scores based on three post intervention labs varied by +/- 1.5 points.

Student surveys following the intervention were also use to document students' opinions about the use of the rubric and templates. All students were surveyed using the same three questions. Predominately (85 %) students thought the rubric's self-assessment and templates were beneficial to complete the lab report to high quality standards. Overall, the intervention was a success for the students and the teacher.

Results

Upon the completion of the six-week intervention in my science classroom, I found three major changes. First, the students' lab write-ups were of higher quality for both regular education students and EEN students. I attributed this in part to the templates (Appendices A- E) that were introduced for the students to use as well as the rubric itself. The templates guided students to write-up a scientific lab and the rubric served as a tool to help them know and understand expectations. One important part of the rubric was a self-evaluation. This was instrumental in forcing the students to look over their work prior to turning it in for a grade. The self-assessment was completed on the same rubric the teacher used for evaluation of the lab report. The teacher could then compare the student's scores to her score to confirm that the self-assessment was utilized by the student for improvement of the lab report prior to turning it in. All students' self-assessment scores were +/- 4 points of the teacher's assessment score. Literature supports that to improve students' work in regards to a process, the same rubric must be used so students can see where their shortcomings are and work to improve them on the next task (Popham, 1997). In the Post Intervention Survey (Appendix F), student comments supported the use of a universal lab with a self-assessment to improve the quality of student lab reports:

The lab guide was helpful because it helped me stay organized and lay out a plan for my lab.

The tool I found the most useful in both labs was the rubric. I thought it was the most useful because I could always refer back to it and see if there was anything I needed to change in my labs.

The rubric helped me with writing my lab because it showed me exactly what I needed to put, so I could make changes while I typed it up.

I could read over the highest point sections (on the rubric), see what was all needed to get that grade, and change what I needed to.

The rubric helped my because when I was done with the lab and graded myself, I was able to see where my problems were and went back and made them better.

I feel my grade on the Stain Remover lab will be higher because I saw what I did wrong on the Barney Juice Lab and made sure I didn't make the same mistakes.

I think it (grade) will be higher on the Stain Remover Lab because I could use my old lab (rubric) and make corrections on what I didn't do correctly.

The second change following implementation of the rubric was grade improvement. The overall average score increased from a D grade to a B-. It was important to note that all students' grades where included, even the students that earned a zero because they chose not to turn in a lab report. The only modification that was made was extra time given for my EEN students that had an Individualized Education Plans (IEP) on file.

The third change was the reduction in evaluating time. All labs were similar in structure. The following parts of a lab were included in all lab reports: problem, hypothesis, material list, procedure, observations in a data table, and a three paragraph conclusion based on their hypothesis, problems the student encountered and future changes. All labs were corrected during prep hours. By using the same time frame each

day, interruptions and distractions were minimal. The following table is an overview of the increase in students' average score and the decrease in time spent evaluating students' lab write-ups.

Changes Due to Implementation of Lab Rubric

Lab	Average Student Score		Time Spent Evaluating
	Regular Ed	EEN	
Paper Towel Lab (Baseline)	65%	68%	11.5 hours
Barney Juice Lab (Working with Intervention)	80%	74%	7.25 hours
Stain Remover Lab (Post Intervention)	82%	77%	6.5 hours

The decrease in time was due largely in part to students' use of the rubric. Expectations regarding lab write-ups were clear and easy for them to follow. Also peer-editing and self-assessment led to review and changes in write-ups. When the labs were finally turned in the reports had gone through the writing process and were of much higher quality. Because I had given students the opportunity to understand and do high quality work, they strove to meet the high standards. In turn this made the labs easier and more enjoyable to read. As an end result less time was spent evaluating the labs and making suggestions for improvements. For the first time I looked forward to reading their work.

Finally, at the conclusion of the intervention, I felt better about the overall grading of my students' labs. The key word in describing change in assessment of students' lab work was 'consistency'. Grading did not occur at once because I had a clear standard for my evaluation. I knew that my standard would not change based on my mood or time constraints. Each student received beneficial feedback about his or her lab. The first lab was graded the same as the last one.

Conclusion

Based on documentation of two additional evaluators, the lab rubric can be universally used to assess middle school lab reports that follow the scientific method. The inter-rater agreement proved that with little explanation a middle school science teacher could use the rubric to assess student lab work.

In addition, I was able to reduce my grading time substantially. This allows me to proved beneficial feedback to my students. By getting their labs back in a timely manner, students are able to implement the needed changes in future lab reports.

Students made increases in the overall score of their lab reports using the templates and the rubric to evaluate their lab write-ups. I feel their lab write-ups are a reflection of true middle school student work. It also supports the idea that students can and will achieve high expectations when given the tools to succeed.

I am proud to share my students' work with others in my field. My students have also increased their ability to reflect on their work. They have begun to develop a life-long skill of critiquing their work and making the needed changes to improve. Students also applied the conclusion template format and signal words to the work they were beginning in their English class. The English teacher has commented on how well the students on our team were able to write complete paragraphs. I am proud to say the implications of the study went well beyond my science classroom.

Future Implications

In the future, I plan to continue to use the rubric to assess my students' lab write-ups. Although I will require my students to complete all parts of the lab write-up based on the rubric, I will only be assessing different parts of the write-

up. As a result of this study, I feel that my students have a good understanding of how to complete an entire write-up. Therefore, I do not need to assess every aspect of it each time. Instead I will concentrate on various components of the write-up. I believe this will reduce my grading time even more, while still providing beneficial feedback to the students.

In addition, a colleague will be implementing a similar rubric in her eighth-grade science class. Together we will be looking to see if students that used the rubric in seventh grade perform higher in her class as eighth graders than their peers who were not exposed to the use of a standard lab write-up rubric.

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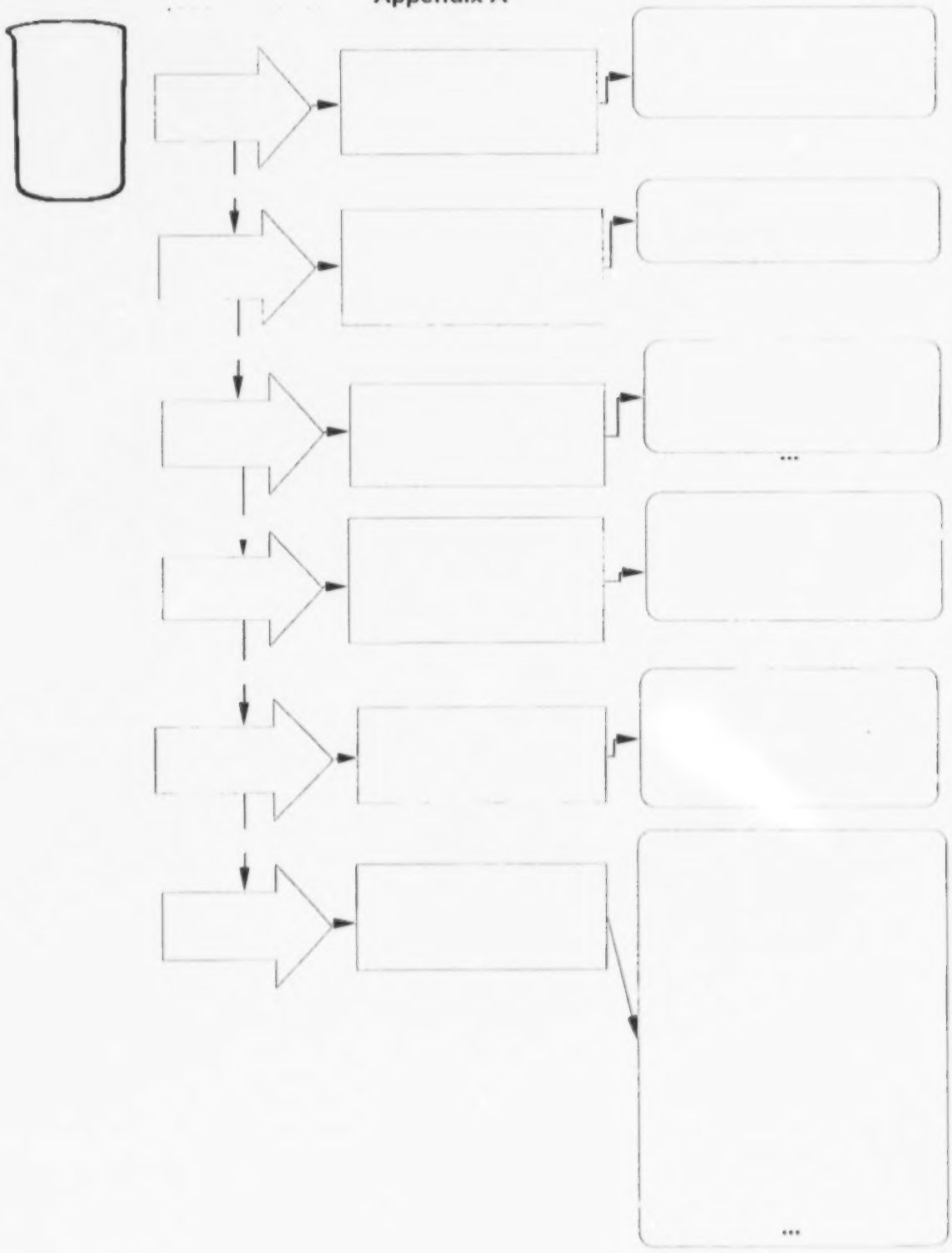
Appendices A-F

Lab Write-Up Tools

Appendix A



Scientific Method Rubric

_____ Lab

Student Name:

Self-evaluation Score:

Category & Total points	Scoring Criteria				Student Evaluation	Teacher Evaluation
	4	3	2	1		
Problem **(3 points)**		Clearly stated in question form and goes beyond the obvious	Clearly stated in question form	Clearly stated		
Hypothesis **(3 points)**		Matches problem, is clearly stated, and can be supported	Matches problem and clearly stated	Matches problem		
Experiment **Materials (2 points)**			All materials are listed	Missing one or more materials off the list		
Experiment **Procedure (4 points)**	Clearly written procedure that can be followed step-by-step	Clearly written procedure with only one step confusing or missing	Clearly written procedure with two steps confusing or missing	Three or more steps confusing or missing		
Observations **(8 points)**	Easy to read and interpret table and/or graph that has straight lines, labels and title	Easy to read and interpret table and/or graph that is missing one of the following: straight lines, labels or title	Easy to read and interpret table and/or graph that is missing two or more of the following: straight lines, labels or title	Table and/or graph are difficult to read and interpret. May be missing one of the following: straight lines, labels or title	X 2	X 2
Conclusion **(12 points)** Each paragraph evaluated individually	Well-written paragraph including all requirements per PHEOC handout.	Contains requirements on PHEOC handout but lacks details to support topic sentence	Missing one requirement from PHEOC handout	Missing two or more requirements from PHEOC handout	1st 2nd 3rd	1st 2nd 3rd
Spelling/ Grammar (4 points)	No errors	1 or 2 errors	3 or 4 errors	5 or more errors		
Neatness (4 points)	Overall appearance is outstanding	Neatly written but overall appearance needs improvement	Handwriting is readable but effort for overall neatness is low	Out of order or written on spiral paper		
Extra Credit (1 point)	Student may chose to share his/her completed lab with a parent, guardian, Mrs. Buchholz or Mrs. Mullen. A signature is required for the extra credit. Parent/Guardian/Teacher Signature:					

Score	**Total Points (40)**
Self-evaluation	Students are expected to honestly evaluate their own work. This is an opportunity for students to reflect on their hard work and be proud of it or to reflect on areas that need improvement. If the difference between the student evaluation and teacher evaluation is more than 5 points, 2 points will be deducted from the teacher's score when the grade is recorded.
Deadline	Lab reports are due at the beginning of class on the assigned day.

***N/A is used for categories not required for the assigned lab. Total points will be adjusted to reflect N/A points.**

Appendix C

Science Lab Report Guide

Student Name:

Lab Problem: (written as a question)

Background Information:

Hypothesis: (what you think and WHY)

Experiment:

Materials (list)

Observations: (chart, data table, drawing, etc.)

Procedure (step-by-step)

Appendix D

Conclusion Template

General lab write-up

Student Name:

Paragraph One Topic: Based on the outcome of your lab, was your hypothesis correct?

Topic Sentence:

Example 1 idea:

Example 2 idea:

Example 3 idea:

Concluding Sentence:

Paragraph Two Topic: What type of problems did you encounter while doing this lab?

Topic Sentence:

Example 1 idea:

Example 2 idea:

Example 3 idea:

Concluding Sentence:

Paragraph Three Topic: What changes will you make the next time you do a lab?

Topic Sentence:_____

_____

Example 1 idea: _____

Example 2 idea: _____

Example 3 idea: _____

_____

_____

_____

_____

_____

_____

Concluding Sentence:_____

_____

Things to remember:

- Your conclusions can be handwritten on loose-leaf paper or word-processed.
- Use signal words to help your writing flow
- Check over your final copy for spelling and grammar errors. It is a good idea to also have someone else read your work.

THIS TEMPLATE IS ONLY YOUR PRE-WRITING AND ROUGH COPY. YOU MUST RE-WRITE THIS INFORMATION IN PARAGRAPH FORM ON LOOSE-LEAF PAPER OR TYPE IT.

Appendix E

Persuasive Writing: Signal Words

Introductory Phrases		
In my opinion	There is no doubt that	I question whether
I believe	From my point of view	I (dis)agree
It is my belief that	It seems to me that	I maintain that

Concluding Phrases			
For the reasons above	To sum up	In short	In brief
As you can see	To be sure	Undoubtedly	In any event
As I have noted	Without a doubt	In conclusion	In any case
In other words	In summation	Obviously	Concluding
On the whole	Unquestionably	Summarizing	

Supporting Opinions			
First	Furthermore	Besides	Further
Second	In addition	Next	Again
Third	Also	Moreover	Similarly
Finally	Last		

Introducing Details		
For example	For instance	In support of this
In fact	As evidence	

Cause and Effect		
Since	Caused by	In effect
Because of	This results in	Brought about
Due to	Consequently	Made possible
For this reason	Accordingly	As might be expected
Therefore	As a result of	Give rise to
If…then	Leads to	Was responsible for

Compare and Contrast			
Similarly	Likewise	As well as	Whether or not
Compared to	In the same way	Have in common	Even though
In like manner	Contrasting	All are	Rather than
On the other hand	On the contrary	The same as	Never the less
Although	As opposed to	Conversely	In spite of

Countering		
I realize you	Believe	But
I understand you	Feel	Yet
Even though you	Maintain	However
Although you	Want	I doubt
Some people	Favor	I question
It may be that you	Support	Let me explain
Your ideas to ___deserves some merit	Argue	On the other hand
	State	On the contrary
		Nevertheless

Appendix F

Post Intervention Student Survey

Name _____ Hour _____

1. Which tool (PHEOC handout, lab guide, rubric, conclusion template, or signal words) did you find most helpful in completing your lab write-up?

2. How did the scoring guide (rubric) help you in completing your final lab write-up?

Do you feel the score you will receive on the Stain Remover Lab (post intervention) will be higher or lower than the score you received on your Barney Juice Lab (during intervention)? Why?

Appendix

One Student's Progression Of Work

Through the Intervention

Lab 1	Paper Towel Lab	Pre-Intervention
Lab 2	Barney Juice Lab	Working with Intervention
Lab 3	Stain Remover Lab	Post Intervention

Paper Towel Lab

Name
Date
Hour

Problem: Which paper towel is the best buy?

Prior knowledge:

	Viva	Bounty	So-Dri
cost	$1.62	$1.42	$0.47
number of sheets	55	96	52

Hypothesis

I think So-Dri will be the best buy because it cost the least amount of money. So it will pick up the most water. Therefore I think So-Dri will be better than Bounty and Viva.

Materials

marbles
pipette
beaker, graduated cylinder
water
ruler

Absorbency

1. Take a beaker put 10 ml of water in it.
2. Stuff a sheet of paper towel in it.
3. Put the rest of the water from the beaker in the graduated cylinder .
4. Measure how much water is left. Then dump the water out.
5. Do for all three.

Durability

1. Have one lab partner hold the paper towel.
2. Put 30 drops of water on the paper towel.
3. Put weights on the wet paper towel.
4. See how many grams it can take record the information. Then clean up.
5. Do for all three.

Size of sheet

1. Take a ruler and measure one side of the sheet.
2. Then measure the other side.
3. Do for all three.

	Size of sheet	absorbing	18 Drops of water
Viva	11 inc by 11 inc.	31mL	55 marbles
Bounty	11 inc by 11 inc.	32mL	78 marbles
So-Dri	11 inc by 11 inc.	18mL	18 marbles

Table:

Conclusion: My conclusion is that Bounty is the best buy because Bounty absorbed the most water, held the most marbles, cost the least, and had the most sheets per roll.

Scientific Method Rubric
Barney Juice Lab

Student Name: Self-evaluation Score:

Category & Total points	Scoring Criteria				Student Evaluation	Teacher Evaluation
	4	3	2	1		
Problem **(3 points)**		Clearly stated in question form and goes beyond the obvious	Clearly stated in question form	Clearly stated	N/A	N/A
Hypothesis **(3 points)**		Matches problem, is clearly stated, and can be supported	Matches problem and clearly stated.	Matches problem	3	1
Experiment **Materials (2 points)**			All materials are listed	Missing one or more materials off the list	0	1
Experiment **Procedure (4 points)**	Clearly written procedure that can be followed step-by-step	Clearly written procedure with only one step confusing or missing	Clearly written procedure with two steps confusing or missing	Three or more steps confusing or missing	3	2
Observations **(8 points)**	Easy to read and interpret table and/or graph that has straight lines, labels and title	Easy to read and interpret table and/or graph that is missing one of the following: straight lines, labels or title	Easy to read and interpret table and/or graph that is missing two or more of the following: straight lines, labels or title	Table and/or graph are difficult to read and interpret. May be missing one of the following: straight lines, labels or title	3 X 2 6	3.5 X 2 7
Conclusion **(12 points)** Each paragraph evaluated individually	Well-written paragraph including all requirements per PHEOC handout.	Contains requirements on PHEOC handout but lacks details to support topic sentence	Missing one requirement from PHEOC handout	Missing two or more requirements from PHEOC handout	1st 3 2nd 3 3rd 3	1st 4 2nd 3 3rd 2
Spelling/ Grammar (4 points)	No errors	1 or 2 errors	3 or 4 errors	5 or more errors	4	4
Neatness (4 points)	Overall appearance is outstanding	Neatly written but overall appearance needs improvement	Handwriting is readable but effort for overall neatness is low	Out of order or written on spiral paper	4	2
Extra Credit (1 point)	Student may chose to share his/her completed lab with a parent, guardian, Mrs. Buchholz or Mrs. Mullen. A signature is required for the extra credit. Parent/Guardian/Teacher Signature:					
Score	**Total Points (40)**				29	26

Self-evaluation Students are expected to honestly evaluate their own work. This is an opportunity for students to reflect on their hard work and be proud of it or to reflect on areas that need improvement. If the difference between the student evaluation and teacher evaluation is more than 5 points, 2 points will be deducted from the teacher's score when the grade is recorded.

Deadline Lab reports are due at the beginning of class on the assigned day.

Barney Juice Lab

Problem: How will the chemicals vinegar, bleach and ammonia effect the barney juice and it's color?

Hypothesis: My hypothesis is that when you add the chemicals to the barney juice the color will change and it will either be on the acid side or base side. Whatever your indicators color is, is the color of neutral.

Experiment: first we/ me and my lab partner/ got the tools we needed to completed the experiment. Then we put tape with numbers 1-4 on the test tubes, and then filled them with 10 ml of barney juice in each test tube, then put 10 drops of either, bleach, vinegar, or ammonia. We waited for the colors to change in each, ten we wrote down are observations, and matched it with are hypothesis. And recorded it.

Observations: My observations for the most part matched my hypothesis.

Chemical	observation	color
Barney juice and Bleach	when bleach was added it was green on top and yellow on the bottom.	Light green with a little yellow
Barney juice and ammonia	when the ammonia was added it changed to green.	Green with blue on the bottom.
Barney juice and Vinegar	when the vinegar was first added it was light red then pink	A redish pink color.

Conclusion: My conclusion for this whole experiment is that when the Barney juice was mixed with the chemicals ammonia, bleach, and vinegar, the colors changed to either base or acid. The colors were all different from each other in some way.

Experiment: Things we used.

1. Test tubes
2. Test tube rack
3. Graduated cylinder
4. PH scale
5. Flask

My hypothesis for the most part was correct. When the bleach was added to the Barney juice the color became a light green with a little yellow. My hypothesis was that the bleach would bleach the color out of the Barney juice making it a light red or pink. Which is on the acid side. My hypothesis was wrong.

My hypothesis for mixing the ammonia with the Barney juice was correct. My hypothesis was that when you mix the ammonia with the Barney juice the out come would be more towards the base side because the Barney is purple and when you mix it with the ammonia the color will turn green or blue.

My hypothesis for mixing the vinegar was correct. My hypothesis was that when you add the vinegar with the Barney juice the color will be more towards the acid side because the

Barney juice is more towards the neutral side, and when you add the vinegar the color will be more towards the acid side.

As you can see, most of my hypothesis were correct.

I didn't really encounter any problems while doing this lab. The lab ran as smoothly as possible. Everything went as planned. The only other problem was that my hypothesis was not correct. Other than that there were no other problems.

The changes I would make the next time would be to think more about my hypothesis, and compare my hypothesis with other peoples. As you can see, I wouldn't make very many changes.

Scientific Method Rubric
Stain Remover Lab

Student Name: Self-evaluation Score:

Category & Total points	Scoring Criteria				Student Evaluation	Teacher Evaluation
	4	3	2	1		
Problem **(3 points)**		Clearly stated in question form and goes beyond the obvious	Clearly stated in question form	Clearly stated	3	3
Hypothesis **(3 points)**		Matches problem, is clearly stated, and can be supported	Matches problem and clearly stated.	Matches problem	3	3
Experiment **Materials (2 points)**			All materials are listed	Missing one or more materials off the list	2	1
Experiment **Procedure (4 points)**	Clearly written procedure that can be followed step-by-step	Clearly written procedure with only one step confusing or missing	Clearly written procedure with two steps confusing or missing	Three or more steps confusing or missing	4	4
Observations **(8 points)**	Easy to read and interpret table and/or graph that has straight lines, labels and title	Easy to read and interpret table and/or graph that is missing one of the following: straight lines, labels or title	Easy to read and interpret table and/or graph that is missing two or more of the following: straight lines, labels or title	Table and/or graph are difficult to read and interpret. May be missing one of the following: straight lines, labels or title	3.5 X 2 7	4 X 2 8
Conclusion **(12 points)** Each paragraph evaluated individually	Well written paragraph including all requirements per PHEOC handout.	Contains requirements on PHEOC handout but lacks details to support topic sentence	Missing one requirement from PHEOC handout	Missing two or more requirements from PHEOC handout	1st 3 2nd 3 3rd 3	1st 3 2nd 3 3rd 3
Spelling/ Grammar (4 points)	No errors	1 or 2 errors	3 or 4 errors	5 or more errors	4	4
Neatness (4 points)	Overall appearance is outstanding	Neatly written but overall appearance needs improvement	Handwriting is readable but effort for overall neatness is low	Out of order or written on spiral paper	4	4
Extra Credit (1 point)	Student may chose to share his/her completed lab with a parent, guardian, Mrs. Buchholz or Mrs. Mullen. A signature is required for the extra credit. Parent/Guardian/Teacher Signature:				1	1
Score	**Total Points (40)**				37	37
Self-evaluation	Students are expected to honestly evaluate their own work. This is an opportunity for students to reflect on their hard work and be proud of it or to reflect on areas that need improvement. If the difference between the student evaluation and teacher evaluation is more than 5 points, 2 points will be deducted from the teacher's score when the grade is recorded.					
Deadline	Lab reports are due at the beginning of class on the assigned day.					

11-1-02

Stain Remover Lab

Problem: What stain will Spray-N-Wash get out the best?

Hypothesis: I think that Spray-N-Wash will get the grape juice out the best. I think that because the *grape* juice is very light and it didn't soak all the way through the fabric.

Experiment:

1.) 2.0 ml of ketchup
2.) 2.0 ml of chocolate
3.) 2.0 ml of grape juice
4.) 2.0 ml of Spray-N-Wash
5.) 3 pieces of rayon
6.) Paper towels
7.) Pipette
8.). Beaker
9.) Marker
10.) Tape

Experiment Procedure:

1. Gather needed materials
2. Put 2.O ml of ketchup on a *piece* of fabric
3. Repeat step 2 using chocolate
4. Repeat step 2 using grape juice
5. Let stain set for 24 hours
6. Put 2.0 ml of Spray-N-Wash on each stain using a pipette
7. Rub In Spray-N-Wash with a wet paper towel for 2 minutes
8. Rinse off each piece of fabric under running warm water for 1 minute
9. Compare to control fabric and record observations

Observations:

Stain Removal Observations

Stain	Materials	Remover	Observation
Ketchup	Rayon	Spray-N-Wash	The stain smeared and then it faded to a light red. You are still able to see it.
Chocolate	Rayon	Spray-N-Wash	There was still a faint chocolate stain. It did not come completely out.
Grape Juice	Rayon	Spray-N-Wash	It came completely out. You cannot see it at all.

Conclusion:

My conclusion for this lab is that my hypothesis was correct. I said that the Spray-N-Wash would get the grape juice out, but not the chocolate and the ketchup. I said this because I thought they would get hard and not come out. As you can see my hypothesis is exactly correct. The things I learned that proved my hypothesis was correct were the ketchup bled through the fabric, got hard, and was very hard to scrub out.

The problems that I encountered while doing this lab were trying to get the ketchup and the chocolate stains out of the fabric, and there were a lot of air bubbles from the Spray-N-Wash in the pipette, so it made it harder for me to be able to read the measurements. Those were the only problems I encountered.

The changes I would make would be to really think through my procedure before I do it. I would change this because while I was doing the lab I kept adding and taking away steps from my procedure. Other than that there is nothing else I would change.

The End

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